SPO
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DARPA Guidance/Navigation Technology

Lt Col Greg Vansuch
Special Projects Office

DARPATech 2000
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Guidance Technology Programs

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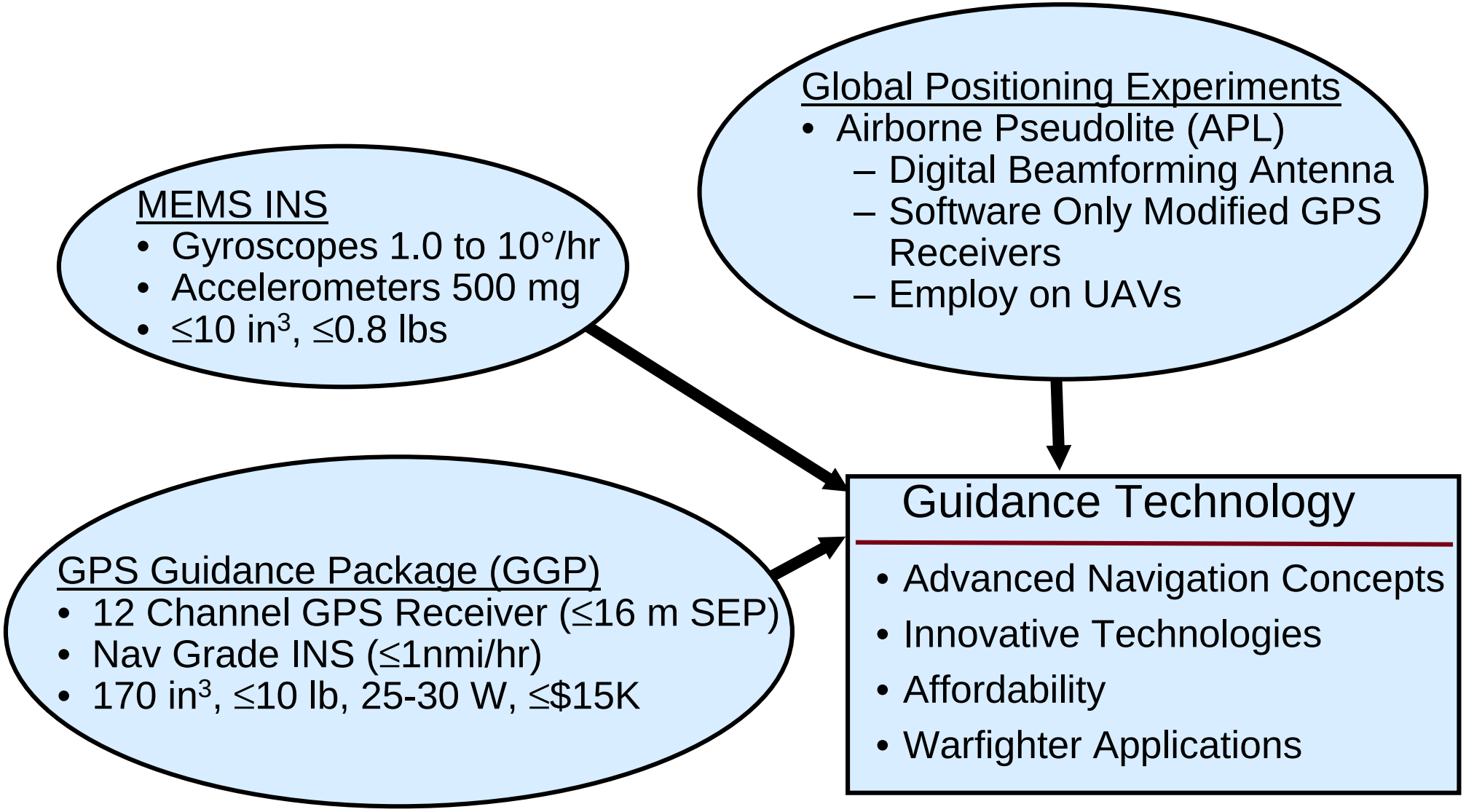

Motivation

- GGP Lowers Cost, Improves Reliability and Improves Performance of Tightly Coupled GPS/INS Navigation
  - Surface to Surface Projectile Launchers (MLRS, HIMARS), Aircraft (F/A-18, Apache), Surface Navigation (M1A2, AAAV), Long Time of Flight Missiles (Tomahawk)
- Tactical Grade MEMS INS Enables Many Applications
  - Inertial Munitions, Personal Inertial Navigation, Personal Underwater Navigation, Micro-Air Vehicles, Tactical Missiles, Unmanned Aerial Vehicles, Sea/Land Vehicle Sensors
- GPX Pseudolites Provide an Augmentation to GPS Signals Under Conditions of Jamming
  - First Launch of L_M Capable Satellite is 2008 or Later
  - IOC for Block IIF Satellites is 2016
  - At Least 10-15 Years Benefit from Airborne Pseudolites

Micro-Electromechanical System (MEMS) Inertial Navigation System (INS)

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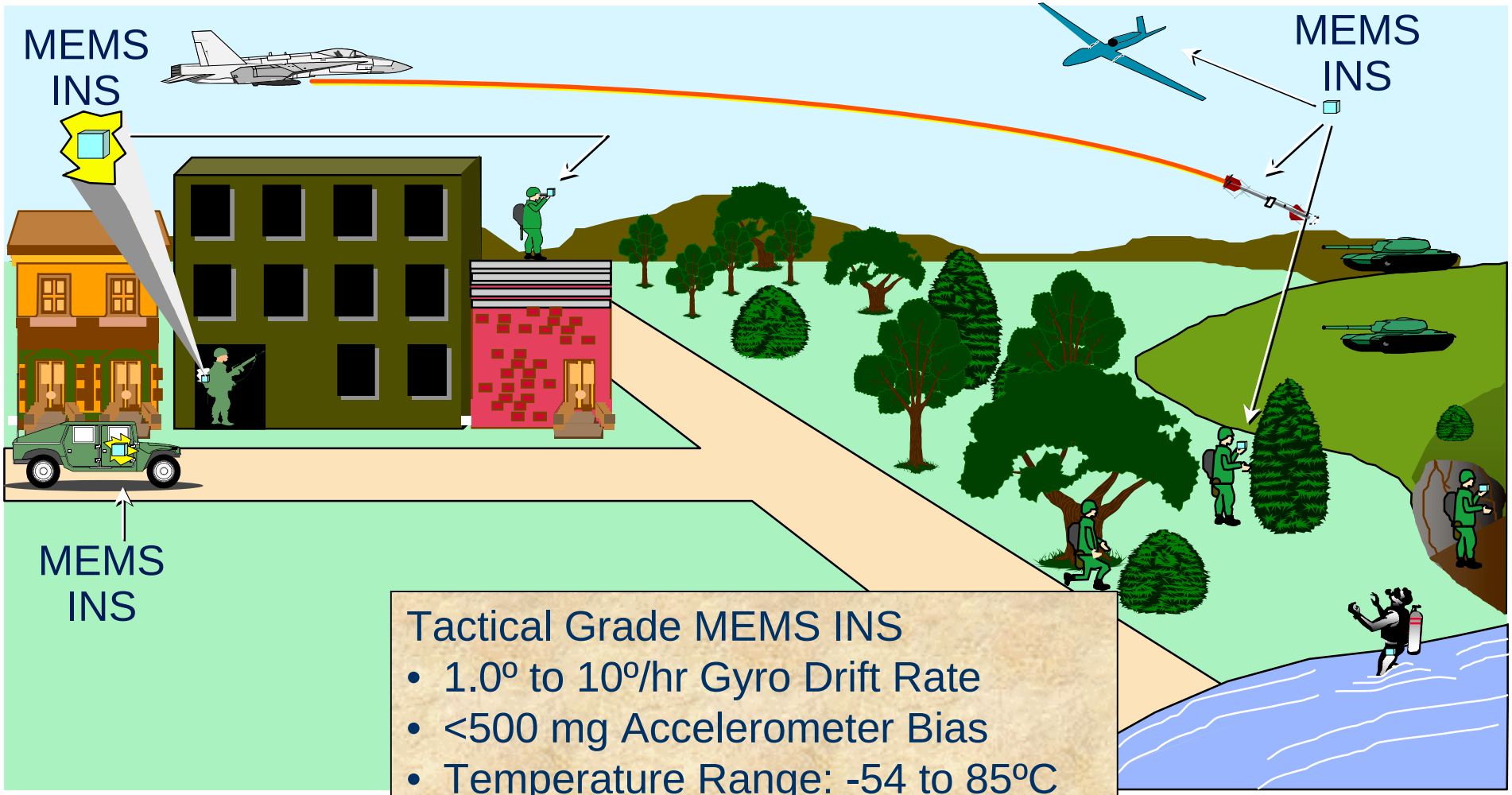

Tactical Grade MEMS INS

- 1.0º to 10º/hr Gyro Drift Rate
- <500 mg Accelerometer Bias
- Temperature Range: -54 to 85ºC
- Low Power: <3 Watts
- Small Size: <10 cu inch

Current MEMS INS Gyroscope Designs

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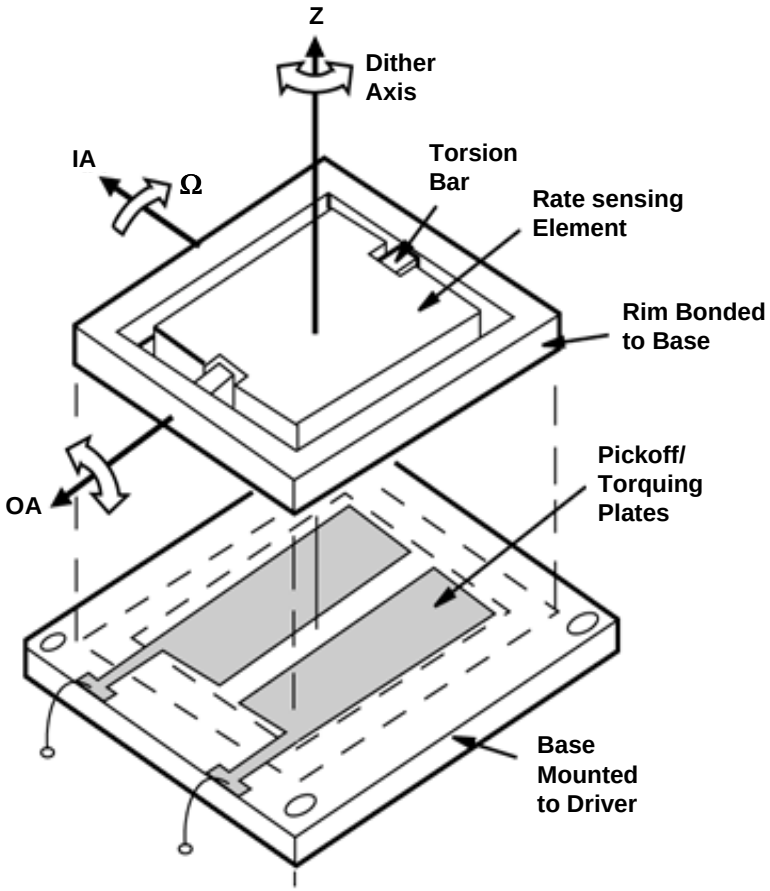
•Litton—Silicon Gyroscope (a conceptual example)

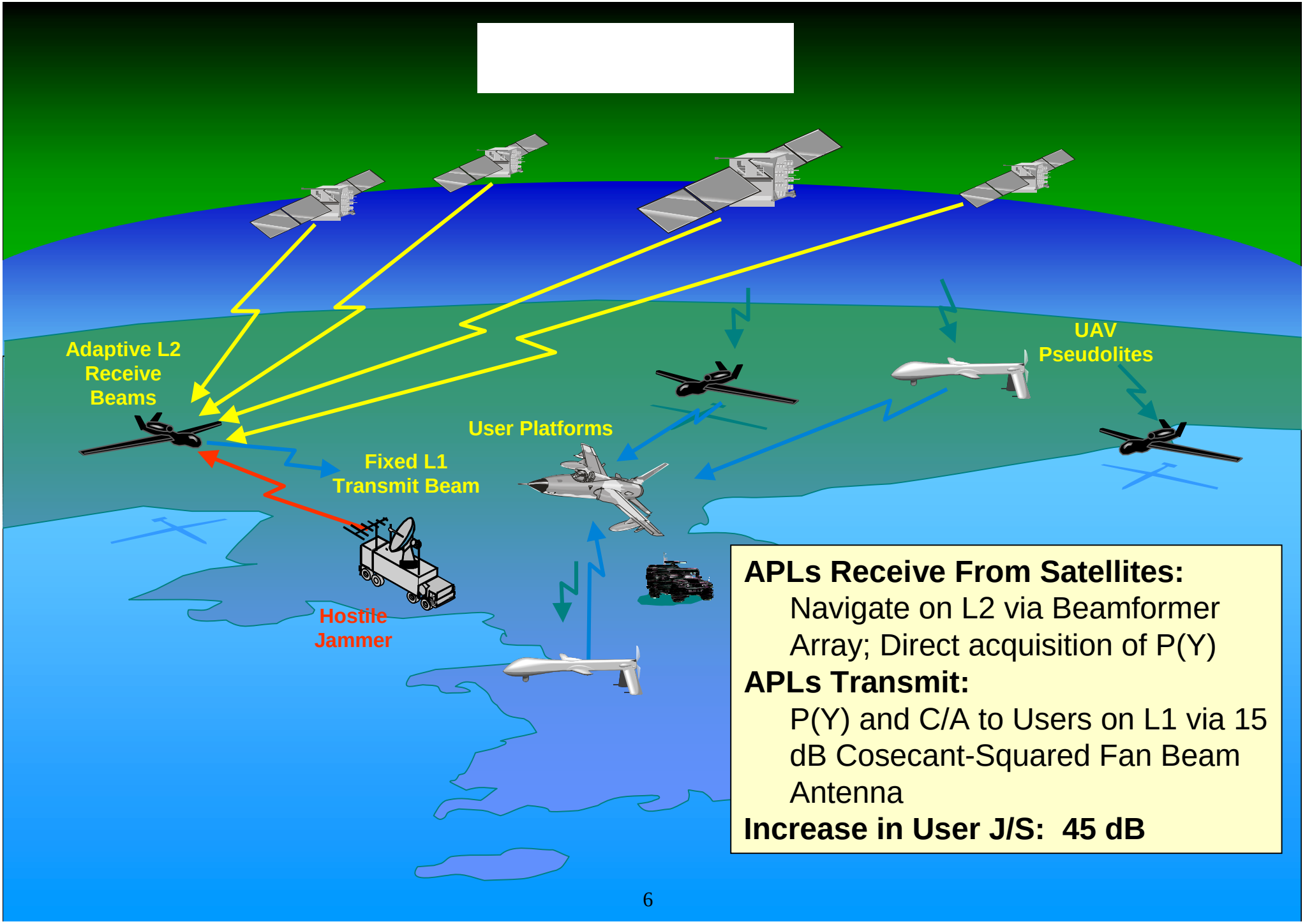


Principle of Operation

- Coriolis Force Sensors
- Measure platform rotation (**W**) around Input Axis (IA)
- Dither device around Dither Axis (z) to produce **v** and –**v** on opposite sides
- Sense Coriolis rotation around Output Axis (OA) using pickoff plates

$$\mathbf{F}_{\text{Coriolis}} = -2\ m\ \boldsymbol{\Omega} \times \mathbf{v}$$

- Draper--Tuning Fork Gyro (TFG)
- Kearfott--Micromachine Vibrating Beam Multisensor (MVBM)



APLs Receive From Satellites:

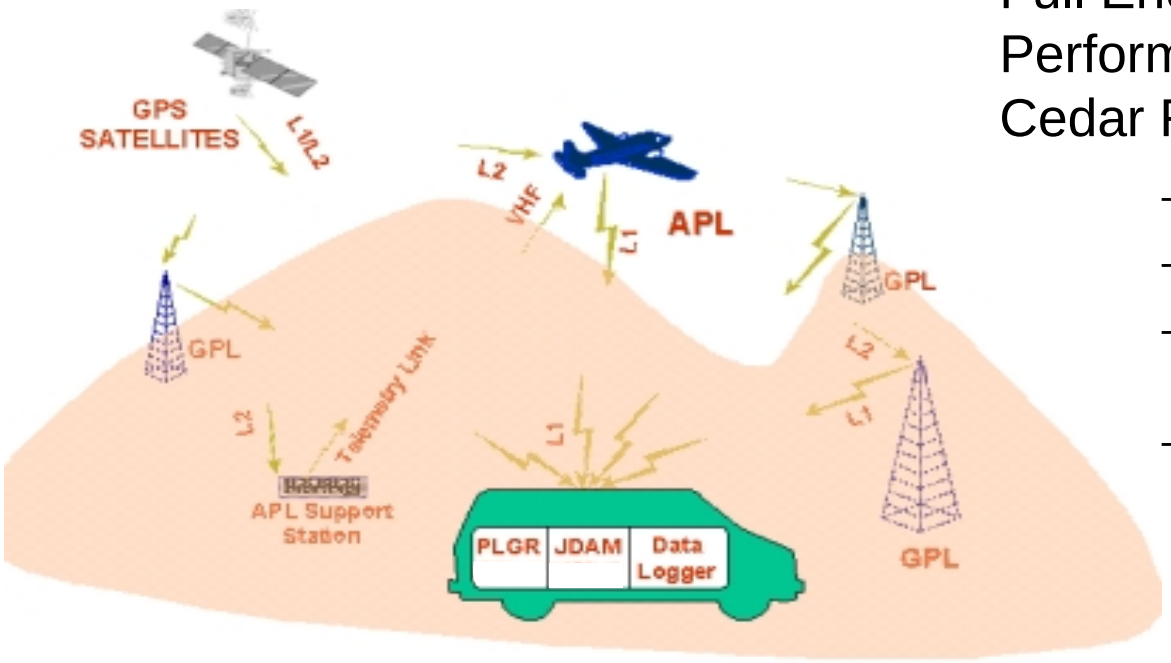
Navigate on L2 via Beamformer Array; Direct acquisition of P(Y)

APLs Transmit:

P(Y) and C/A to Users on L1 via 15 dB Cosecant-Squared Fan Beam Antenna

Increase in User J/S: 45 dB

First Flight Demonstrations (GPX)



- First Airborne Pseudolite (APL) Broadcast (9/99)
- Full End-to-End APL/GPL/UE Performance Demonstrated Live in Cedar Rapids, IA (11/99)
  - **3 GPLs Located on Fixed Towers**
  - **One APL on Sabreliner Commercial Jet**
  - **Handheld PLGR GPS Receiver and JDAM GPS Receiver Located in Moving Van**
  - **Demonstrated and Assessed Geolocation Performance in a Variety of Static and Dynamic Scenarios; User Receivers Operated Without GPS Satellites**

Successful Navigation Demonstration

Demonstrated Range Error of 4.36 m (Original Estimate 4.5m; Goal 10m)

UAV Flight Demonstration

When

April 2000

Where

Fort Huachuca, AZ

What

Demonstrate APL Effectiveness against GPS Jamming

Results

- Modified PLGR, JDAM worked in jamming
- Unmodified PLGR jammed

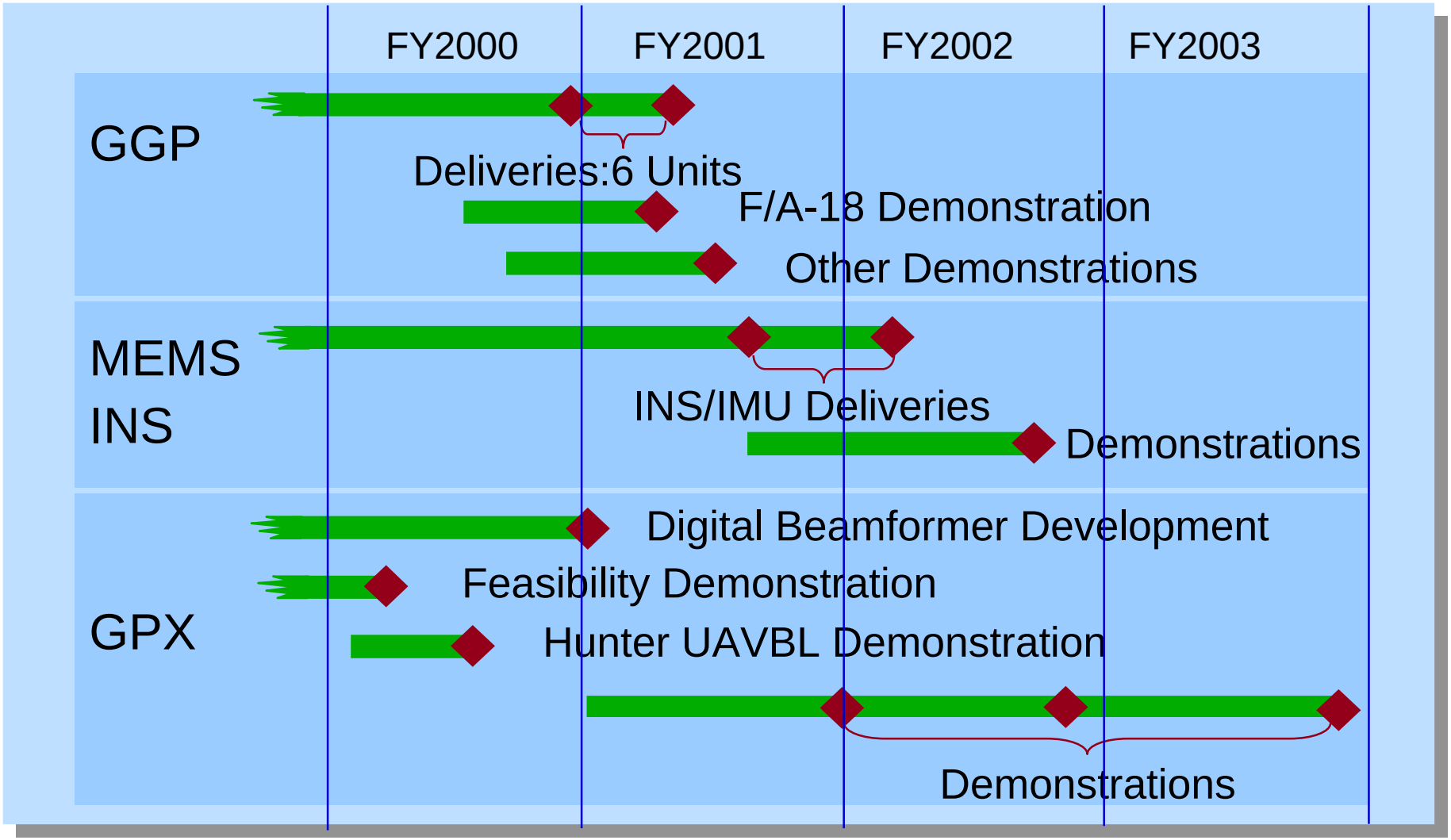
Hunter UAV

Boom Pod

- **Air Force UAV Battlelab and DARPA Funding**

Successful Navigation in Jamming

Guidance Technology Schedule



Conclusions

- GGP
  - Potential F/A-18 and MLRS Demonstrations
- MEMS INS
  - Laboratory Results Indicate Progress Toward 1-10°/hour Over Military Environment
- GPX
  - Successful Feasibility Demonstrations Completed
  - Demonstrations of Beamformer, Transmitter, Transparency, Multiple Platforms, and Live Fire Being Planned
- New Ideas?

Multifaceted, Innovative Navigation and Guidance Technologies for the Warfighter